

DISCOURSE PROCESSING PROCEDURES*

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1.0 INTRODUCTION

A number of authors have been concerned to provide a tighter, more formal account of how speakers of English come to identify a text as forming a text. (cf. van Dijk (1977), Halliday and Hasan (1976)) They have explored the mechanisms how large chunks of utterances come to be interpreted as texts. It is, however, only fair to point out, for example, Halliday and Hasan (1976), that they are not concerned to provide a description which explains how texts are interpreted. They are mainly concerned to examine the linguistic data available to the listener or reader, to establish cohesive relationships. Any adequate model of discourse description should be able to accommodate the appropriate system of discourse interpretation. Recent studies in both artificial intelligence and linguistics have demonstrated the need for a theory of anaphora interpretation which accounts for the role of syntactic and semantic effects, as well as inferential knowledge¹ in explaining how anaphors are interpreted. In this paper a new approach to discourse anaphora, based on the concept of focusing proposed by Grosz (1981) and Sidner (1983), will be introduced to explain the interpretation of definite anaphors in a discourse.

1.1 FOCUSING AND COHESION

When two people meet and talk about something, they usually focus on a small part of what each of them knows or believes and wants to inform to the other. Certain elements of this part which represent some objects, events, or relationships and the like are central to the dialogue at certain point and are focused on more sharply than others. This process is FOCUSING introduced by Grosz (1981) :

Focusing, then, is the active process, engaged in by the participants in a dialogue, of concentrating attention on, or highlighting, a subset of their shared reality. (Grosz (1981 : 84))

Grosz also informally use the term FOCUS. In a discourse a speaker and a hearer center their attention on a particular discourse element. Then, following Grosz, I call this element as FOCUS. The notion of focusing is very close in its concept to COHESION proposed in Halliday and Hasan (1976) :

The concept of cohesion is a semantic one ; it refers to relations of meaning that exist within the text, and that define it as a text. Cohesion occurs where the INTERPRETATION of some element in the discourse is dependent on that of another. (Halliday and Hasan (1976 : 4))

Both of FOCUSING and COHESION have in principle nothing to do with sentence boundaries. Focusing is a discourse phenomenon rather than one of single sentences. Cohesion is a semantic relation between an element in the text and some other element

that has information in need to interpret it. Cohesion is a necessary though not a sufficient condition for the creation of text. What creates text is the TEXTUAL, or text-forming, component of the linguistic system, of which cohesion is one part. The same is true to Focusing.

The difference between FOCUSING and COHESION lies in the manner of contribution to the interpretation of a discourse. If there is a relationship where the interpretation of some element relies on the other, cohesion occurs. The view of the discourse in the case of cohesion is rather static compared with that in the case of focusing. Focusing is the active process, by the participants in a discourse, of concentrating their attention on what they intend to inform. There is another more crucial difference between the two. As I have already mentioned in Introduction, cohesion could not provide a description which explain how texts are interpreted. On the other hand, focusing, illustrated in the following sections, is proposed to contribute the interpretation of the text.

1.2 FOCUSING AND ANAPHORA

A discourse is usually built up by the mutual interaction between speakers and hearers. For example, the speaker A takes the first step by uttering something, focusing on certain elements in it. Then the person who has been the hearer B comes to be the speaker B, takes over the focus and attaches new information on it in his response to A. Then A takes over the message of B. In this way speakers and hearers cooperate to develop a coherent discourse. One would expect that in the proc-

ess of taking over the focus realized by certain elements in each sentence reintroduction of the focus would be necessary. However, reintroduction of the focused element as it is seems to be not only redundant but also inefficient and awkward process in the discourse. In English and in other languages one would find useful devices by which one could take over the focus and thus maintain the coherence of the discourse without increasing redundancy. It is traditionally called ANAPHORA and realized in the form of anaphoric expressions. Thus far linguists have been mainly concerned with the interpretation of anaphors in the realm of Sentence Grammar and proposed several constraints on them. In their studies (Langacker (1969), Jackendoff (1972), Lasnik (1976), Reinhart (1976), Chomsky (1981)), they have proposed several constraints from the syntactic point of view. What they have in common is the idea that antecedents and anaphors should obey certain structural restrictions based on COMMAND or C-COMMAND. On the other hand, there are few literatures which deal anaphora in the framework of Discourse Grammar. Kuno (1975, 1978) and Webber (1978) are important works in this field.

1.3 OUTLINE OF THE DISCOURSE PROCESSING PROCEDURES

1.3.1 Initial Setting

The first step of the discourse processing procedures is to specify the focus in the first sentence in a discourse. It is, however, not so easy as to point out the most highlighted element in a simple sentence. The selection of the initial focus depends not

only on the syntactic and semantic information available in the discourse initial sentence but on the information available later in the development of the discourse. Thus in this first step what we can do is just choosing a possible focus, which will be accepted or rejected in the following discourse on the basis of anaphoric expressions. Sidner proposes the focusing algorithm, some of which are realized as the processing device in the following sections, to interpret a discourse. Sidner presents the following examples to secure the algorithm :

- (1) Mary took *a nickel* from her toy bank yesterday. She put *it* on the table near Bob. (it=a nickel)
- (2) A group at HXN developed *a high speed technical chip packer*. The press gave *it* rave reviews. (it=a high speed technical chip packer)

In (1) *a nickel*, the theme of the sentence, is more liable to be the antecedent of *it* than *a toy bank*, the locative. The same is true in (2) ; *a high speed technical chip*, the theme, is more liable to be the antecedent of *it* than *a group*, the agent of the sentence. She mentions". . . the noun phrase in a prepositional phrase following the theme cannot be the focus of the discourse unless the expected focus is explicitly overridden by a full definite noun phrase co-specifying with some other phrase of the initial sentence. . . One thematic position that is not preferred for discourse focus is the agent." (Sidner (1983 : 284-5))

Sidner proposes EXPECTED FOCUS ALGORITHM :

- (3) The first member of the default expected focus list (DEF list), computed from the thematic relations of the verb, as follows :

Order the set of phrases in the sentence using the following preference schema :

- theme unless the theme is a verb complement in which case the theme from the complement is used.
- all other thematic positions with the agent last
- the verb phrase (Sidner (1983 : 287))

Now let us examine how this algorithm works at the first step of discourse processing. The following is a dialogue between two people, an expert and an apprentice, working together to complete a task of disassembling an air compressor :

- (4) Expert (E) : First you have to remove the flywheel.
- (5) Apprentice (A) : How Do I remove the flywheel?
- (6) E : First, loosen the two allen-head setscrews holding it to the shaft, then pull it off.
- (7) A : OK.

Sidner's focusing algorithm can choose *the flywheel* as the expected focus in this discourse. I adopt her idea of focusing algorithm in the framework of discourse processing and hypothesize the following procedure :

- (8) Pick up the thematic element in the initial sentence of a discourse and name it as CANDIDATE DISCOURSE FOCUS (CDF).

The word "CANDIDATE" is intended to express the uncertainty of the element which will be confirmed or rejected in the following discourse. When one looks at the discourse with special attention on *the flywheel* in (4), one realizes that *the flywheel* is repeated in (5) and then expressed as *it* in (6). In 1.2 I have

mentioned that the anaphoric expressions which occur in the second and the following sentences in the discourse (if there are any) would have the function of taking over the highlighted message, the focus, uttered in the previous in that discourse. That is, the anaphoric expressions appeared in the second and the following sentences are used as signals of discourse focus. I propose the following procedure along the line above :

- (9) CANDIDATE DISCOURSE FOCUS is qualified as DISCOURSE FOCUS (DF) if and only if it is to be expressed by an anaphoric expression² in the following discourse.

Note that the statement (9) presupposes that if CDF is not qualified as DF in the following discourse, then it loses the qualification of CDF. This presupposition may reflect the function of the short term memory which deletes unnecessary information in order to lessen the loads of memory. Consider once again the discourse (4)–(7). *The flywheel* (CDF) in (4) is confirmed as DISCOURSE FOCUS in (5)–(6), for it is repeated in the form of the definite NP in (5) and in the form of the pronoun in (6).

1.3.2 DISCOURSE FOCUS AND PARTICIPANT FOCUS

Before I proceed further to show the other crucial procedures, I want to mention the significance of dividing focus into two subclasses, DISCOURSE FOCUS and PARTICIPANT FOCUS. Grosz points out the observation :

...an actor is involved in focusing. If an entity is in focus, it is the object of someone's focusing; it cannot be impersonally in focus. When I use the constructions "highlighted", "focused on", or "in focus", there is always an implicit actor

doing the highlighting or focusing. (Grosz (1981 : 84))

She claims that whenever focusing occurs, there should be an actor who focuses on the element. Sidner also informally supports the significance of the distinction :

An actor focus is a discourse item which is predicated as the agent in some event. It is distinct from the main focus, which will be called the discourse focus. Actors can become the discourse focus only when no other item is available for focusing. Actors must be specified separately because (1) the focus of the discourse often is distinguished from the actor, and (2) actors can be spoken of anaphorically at the same time that the discourse focus is pronominalized. (Sidner (1983 : 282))

The following example clearly exemplifies the participant focus—discourse focus distinction :

- (10) During a stretch of narrative discourse, *a speaker* may wish at some given point to talk about a **particular referent**. If **this referent** is not present in the speech situation, if *the speaker* has never mentioned **it** in previous utterances, and if *his* listener cannot be assumed to know anything about **it**, *he* must somehow “introduce” **it** in discourse in order to say something about **it** in the utterances which follow. (Hickmann (1980 : 192))

The relationship between the participant focus and the discourse focus seems to be the relationship between the warp and the weft that make up the texture. The discourse focus is what the participants currently highlight and the participant focus specifies

the current participants involved in the action or the event in that discourse. Both of them are essential to make a collection of sentences into the coherent discourse.

I will present more significant examples which will be given an appropriate interpretation by the constraint proposed in 1.3.5.

(11) John, Bill and Harry used to come to my room after school and talk about their car.

(a) Harry always complained of the heavy steering wheel of Bill's car.

(b) *Bill's car, it is the heavy steering wheel that Harry always complained of.

(12) Joan had never spent much time in her grandmother's room in her childhood. Because it was dark and damp.

(a) Her grandmother, Joan always complained of about her room.

The difference of the acceptability in (11a), (12a) and (11b) seems to reflect the distinction of the participant-discourse focus. This distinction will contribute the interpretation of anaphora in discourse in the sense that it is reflected in the constraint in 1.3.5.

1.3.3 FOCUS CHANGING MECHANISM

In 1.3.1 we have picked up and confirmed the discourse focus, then taken the first step into the discourse concerned. Although there may be only one discourse focus in it, there are usually more foci in the discourse that we encounter in our daily life. The following is such a discourse, a part of which is already shown above :

- (13) Expert (E) : First you have to remove the flywheel.
- (14) Apprentice (A) : How Do I remove the flywheel?
- (15) E: First, loosen the two allen-head setscrews holding it to the shaft, then pull it off.
- (16) A : OK.
- (17) A : I can only find one screw. Where's the other one?
- (18) E: On the hub of the flywheel.
- (19) A : That's the one I found. Where's the other one?
- (20) E: About ninety degrees around the hub from the first one.
- (21) A : I don't understand. I can only find one. Oh wait, yes I think I was on the wrong wheel.
- (22) E: Show me what you are doing.
- (23) A : I was on the wrong wheel and I can find them both now.
- (24) A : The tool I have is awkward. Is there another tool that I could use instead?
- (25) E: Show me the tool you are using.
- (26) A : OK.
- (27) E: Are you sure you are using the right size key?
- (28) A : I'll try some others.
- (29) A : I found an angle I can get at it.
- (30) A : The two screws are loose, but I'm having trouble getting the wheel off.
- (31) E: Use the wheelpuller. Do you know how to use it?
- (32) A : No.
- (33) E: Do you know what it looks like?
- (34) A : Yes.
- (35) E: Show it to me, please.
- (36) A : OK.

- (37) E: Good. Loosen the screw in the center and place the jaws around the hub of the wheel, then tighten the screw onto the center, of the shaft. The wheel should slide off. (Grosz (1981 : 85–86))

We have defined *the flywheel*, the theme as Candidate Discourse Focus (CDF) in (13) and confirmed it as Discourse Focus (DF) in (14)–(15) along the line proposed in (9). Now consider (15)–(23). A new CDF, *the two allen-head setscrews*, appears in (15) and it is confirmed as DF by anaphoric expressions, *one screw* and *one*, in (17). From (17) to (23) they are talking about *the two allen-head setscrews*. *The setscrews* are focused throughout this domain (17)–(23). Put it in other way, *the setscrews* (DF) govern this domain. Thus, I propose a new framework, larger than a sentence and smaller than a discourse, and name it as FOCUS DOMAIN.

- (38) Define a part of a discourse as FOCUS DOMAIN which DISCOURSE FOCUS governs.

What I mean in the use of ‘govern’ is due to the fact that DF (the setscrews) could not be interrupted without any good reason in a discourse. I will come back to this notion in 1.3.4.

Now let us consider the change of DF from *the flywheel* to *the allen-head setscrews* in (15)–(17). *The two allen-head setscrews* which was CDF in Focus Domain of *the flywheel* (13)–(15) is now DF in Focus Domain of *the two allen-head setscrews* (16)–(23), for they are expressed by the anaphoric expressions in this domain. Then, what will be the status of the former DF, *the flywheel*? When we carefully look at the discourse, we recognize that it appears again in (30) and (37). It

is reasonable to hypothesize the following mechanism :

- (39) FOCUS CHANGING MECHANISM: When a new CANDIDATE DISCOURSE FOCUS is confirmed as DISCOURSE FOCUS, then the previous DISCOURSE FOCUS automatically turns to be an OLD FOCUS (OF) and saved in a OLD FOCUS LIST (OFL).

This mechanism is based on the concepts of HOLD and HOLD LIST introduced in the theory of Augmented Transition Network (ATN) proposed by Wanner and Maratsos (1978)³. Let us see how this mechanism works in the discourse. Since CDF (*two allen-head setscrews*) is confirmed as DF in (17), previous DF (*flywheel*) turns to be OF and saved in OFL. Then this DF (*two allen-head setscrews*) turns to be OF in (24) in the next focus domain, for the new thematic element, *the tool*, is picked up as CDF and confirmed as DF in the next sentence in (24).

1.3.4 RETRIEVING MECHANISM

The same procedure proposed in (39) is applied to the other CDFs and DFs in the discourse. However, when we come to (29), we face at the pronoun *it* in the focus domain of *the key* (27)–(29). We cannot give *it* an appropriate interpretation, for the current focus is on *the key*. Then, we have to search it elsewhere in OLD FOCUS LIST where old foci are saved in sequence, that is, OLD FOCUS saved first is put at the bottom of the list, the second OLD FOCUS is put one list above the first. I hypothesize that we cannot have direct access to the older old focus beyond the other new ones⁴:

- (40) FOCUS RETRIEVING MECHANISM: If an anaphoric

expression fails to be given an interpretation in the different Focus Domain, then retrieve the appropriate OLD FOCUS (OF) from OLD FOCUS LIST (OFL) in the manner "last in first out".

When we retrieve OF from OFL in (31), we have such OFL where *TOOL*, *SETSCREW*, and *FLYWHEEL* are on the list in this order from the top. First we have to gain access to *TOOL*, but this does not match the context and is rejected by certain PRAGMATIC COMPATIBILITY CONSTRAINT which must be defined elsewhere in Discourse Grammar. Then, *SETSCREW* is taken out of the list and this time it matches the context. Thus, the pronoun *it* is correctly given the interpretation of *setscrew* in (31).

1.3.5 DISCOURSE FOCUS CONSTRAINT

I have already presented a few examples in 1.3.2 that support the idea of distinguishing the discourse focus from the participant focus. (cf. (11)–(12)) This will be further confirmed by the following examples which illustrate the contrastive behaviors of the discourse focus and the participant focus.

- (41) Yesterday, a policeman came to see me and asked whether I had heard a scream in the back yard.
- a. As for that incident, according to the newspaper, the burglar escaped through the attic window.
 - b. ?As for that incident, with reference to the newspaper, the burglar escaped through the attic window.
 - c. ??As for that incident, according to the newspaper, the attic window, the burglar escaped through (it).
 - d. *As for that incident, with reference to the news-

paper, the attic window, the burglar escaped through (it).

(42) John, Bill and Harry used to come to my room after school and talk about their car.

a. Harry always complained of the heavy steering wheel of Bill's car.

b. *Bill's car, it is the heavy steering wheel that Harry always complained of.

(43) Joan had never spent much time in her grandmother's room in her childhood. Because it was dark and damp.

a. Her grandmother, Joan always complained of about her room.

Unacceptability or low acceptability of (41b,c,d) and (42b) is due to the fact that CDF (*that incident*) conflicts with CDFs (*the newspaper* in (41b), *the newspaper* and *the attic window* in (41c, d) and that DF (*Bill's car*) conflicts with CDF (*the heavy steering wheel*) in (42b). On the other hand, even two participant foci (*grandmother, Joan*) occur in (43), there is not such a conflict between the two participant foci. It is reasonable to assume the following constraint which governs the peculiar behavior of DFs.

(44) DISCOURSE FOCUS CONSTRAINT: More than one different (Candidate) Discourse Foci cannot occur in a single sentence in the discourse⁵.

This constraint will be also supported by the Japanese discourse:

(45) Yamadasan wa konoaida okusan ga uraniwa niaru kura de mitsuketa tsubo wa, iromo azayakade yoi ne ga tsukudarou to omotteita. Tokoroga zannen na kotoni,

sono tsubo wa ikkasho dake chiisana hibi ga (*wa)
mitsukari, omotteitahodo takaku urenakattanode kare
wa gakkarishita.

- (46) Suzukisan wa, Tanaka moto shusho wa konosai isagi-
yoku mi o hikubekida, to iu kangae o motte itaga, joshi
wa sorenitsuite amari kokoroyoku omotte inakatta. To
iunomo kare wa Niigata-ken shusshin de ari, Tanaka
moto shusho wa kyodo ga unda ijin de aru to shinjite
ita karadearu.

In (45), DF (*tsubo*) conflicts with CDF (*hibi*) in a single sentence. Thus Discourse Focus Constraint correctly rejects (45) in the case of *hibi wa*. On the other hand, even two participant foci (*kare* and *Tanaka moto shusho*) occur in the same sentence in (46), this sentence is perfectly acceptable, which will be predicted by the constraint (44) and also support of proposing the distinction between the discourse focus and the participant focus.

1.4 CONCLUSION

In this paper the concept of focus has been introduced and several procedures based on it and a constraint have been proposed to interpret anaphoric expressions in a discourse. Now we have a complete structure of DISCOURSE PROCESSING PROCEDURES:

- I. CANDIDATE DISCOURSE FOCUS (8)
- II. DISCOURSE FOCUS (9)
- III. FOCUS DOMAIN (38)
- IV. FOCUS CHANGING MECHANISM (39)

V. FOCUS RETRIEVING MECHANISM (40)

VI. DISCOURSE FOCUS CONSTRAINT (44)

Although there remain various kinds of unsettled problems in the study of discourse, the computational model of discourse will be a promising approach to interpret the anaphoric expressions in a discourse. I hope that the present paper will contribute to the study of discourse.

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FOOTNOTES

1. Webber (1977) points out that "the speaker assumes the listener can and will follow the speaker's unspoken lead to infer :
 1. from description d_1 of some entity in his or her discourse model, another description d_2 of that same entity ;
 2. from entities e_1, \dots, e_j with description d_1, \dots, d_j respectively a new discourse entity e_k with description d_k ."

She shows the following example :

- (i) I have a '71 Ch. Figeac, a '76 Fleurie, a '71 Ockfener Bockstein and a '75 Durkheimer Feuerberg in the cellar. Shall we have the German ones for dinner tonight? (ones =wines)

The speaker in (i) assumes that the listener both can and will infer the topic (*wine*) from the description "*'71 Ch. Figeac*" and "*the cellar*" and that the listener will correctly interpret "ones" as "wines".

2. I include, for the moment, epithets and repeated noun phrases in the category of the anaphoric expression. Since I delimit the scope of the research on the definite anaphors, I will not discuss in this paper so-called 'null anaphora' such as VP Deletion, Gapping, Sluicing, and other surface anaphora defined in Hankamer and Sag (1976).

3. Their theory of Augmented Transition Network (ATN) is a set of parsing mechanism whose target is a sentence, not a discourse.

4. The concept of this hypothesis is based on the grammar of the artificial language of a personal computer, BASIC. Specifically, it is based on "sequential file", which, roughly speaking, sequentially stores data and accesses them in the manner "first in—first out".

5. It must be considered the possibility of such a focus combination as one of the Discourse Foci happens to be still Candidate Discourse Focus in a sentence. For example, *the heavy steering wheel* in (42b), which appears for the first time in the focus position in a sentence structure, is qualified as Candidate Discourse Focus. Thus I parenthesize *Candidate* in (44).

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